Establish Project Control

Terminal Learning Objective

- Action: Establish control traverses using optical and GPS equipment to guide horizontal and vertical construction project layouts
- Condition: In a classroom and field environment provided written project specifications, a survey set (G.P.), and references.
- Standard: Established Project Control to third order of accuracy.

Enabling Learning Objectives

- Use survey controller to operate survey instruments.
- State the characteristics of the S6 total station.
- Identify control station locations, to guide horizontal and vertical construction project layouts.
- Prepare the S6 total station for operation.

Enabling Learning Objectives (Cont.)

- Measure control stations using automated rounds.
- State the characteristics of the R8 GPS surveying system .
- Identify control station locations.
- Prepare the R8 GPS surveying system for operation.

Enabling Learning Objectives (Cont.)

- Measure control stations using Real Time Kinematic surveying.
- Post process the data to refine survey.
- Perform site calibration adjustment.

Administrative Data

- Method/Media: Lecture, slide show, demonstration, practical application
- Safety: No major safety concerns
- Risk Assessment Level: Low
- Environmental Considerations: None
- Evaluation: Students must score a minimum of 80% on a Written Evaluation and receive a GO on a Performance Evaluation.

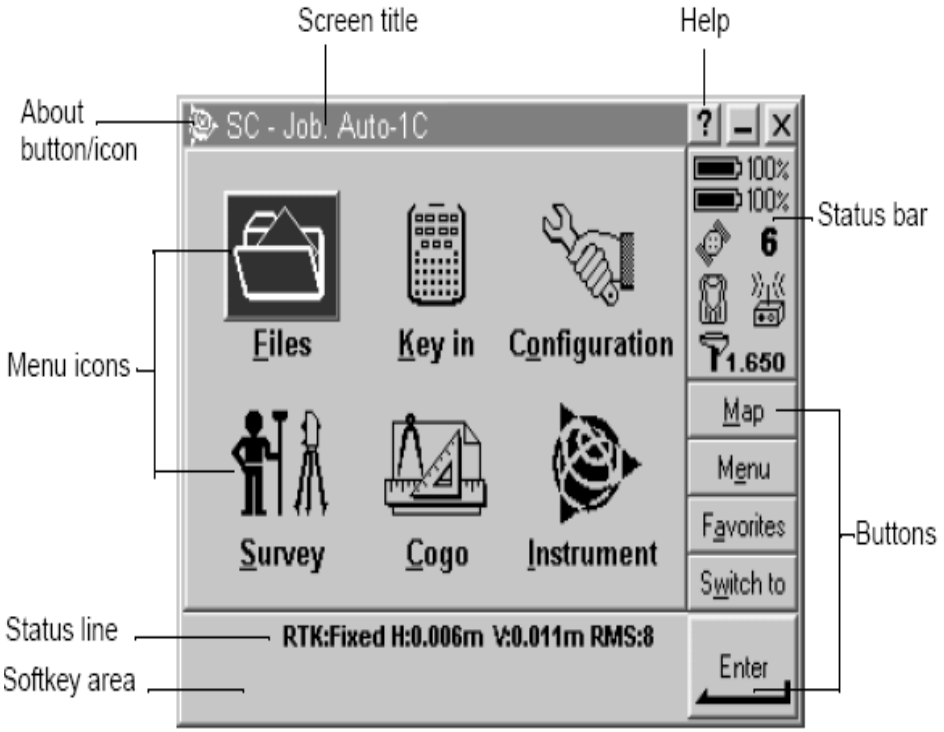
Survey Controller

Survey Controller

- The Survey Controller program is a Windows based surveying module on the Control Unit.
- It allows the surveyor to collect field data with a user friendly Windows interface.
- Can be used with Optical, GPS, and third party surveying equipment.

Ranger

- When the Ranger is connected to an instrument the status will be displayed in the status bar on the right side of the screen.



Station Establishment

- Station establishment must be performed before any type data collection can be initialized.
- Upon starting station set up the surveyor will need to correct for systematic errors.
- Keyed information includes: point name, pcode, instrument height, coordinates, and whether or not the occupied point is a control point.

Measure Topography

- Select the type of data collection under the survey option of the Survey Controller main menu.
- After the Measure Topo has been initialized the surveyor is prompted for the following information: starting point name, pcode, target height.
- When the distance is measured all information can be stored.

Measure Rounds

- Measure Rounds is the traversing tool on the Ranger .
- Information is keyed in the same way as Topo, with the exception that the surveyor can exclude the original backsight used in station establishment.

Autolock Feature

- Autolock can be engaged by accessing the Trimble Functions screen from the status bar.
- Trimble Functions also has the search capabilities if the target is lost.

Lines and Blocks

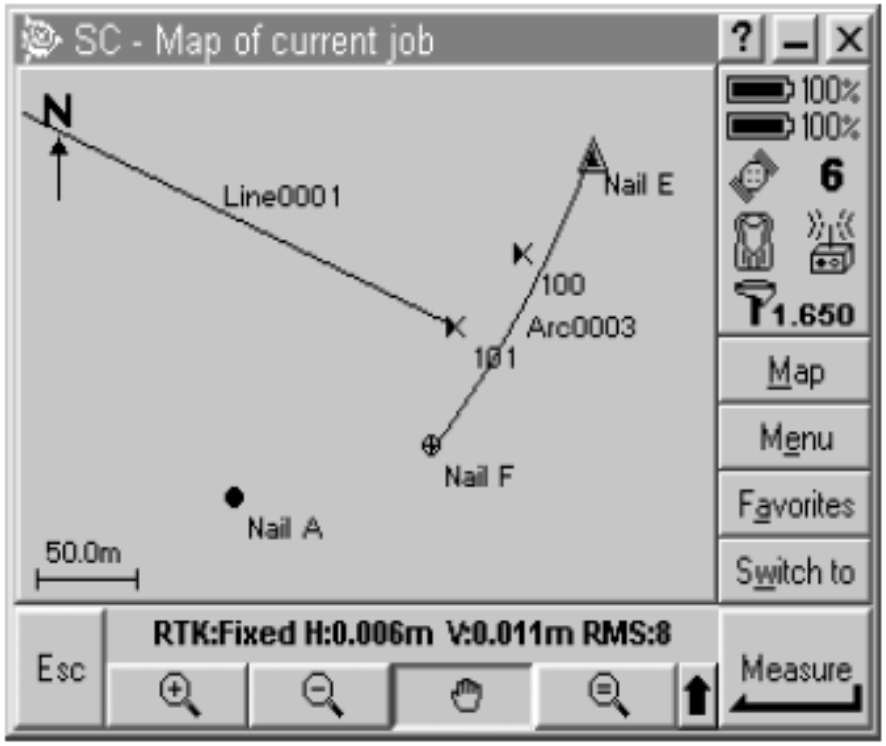
- Pcodes must be used during data collection.
- When creating a new file ensure that a Pcode feature library is linked to the new file.
- The feature library will be able to draw linework and blocks to collected data on the Ranger.
- Surveyors can check the accuracy of keyed data during the survey by

Map Function

- The map function on the Ranger is easily accessed by pressing the Map button under the Status Bar.
- The map function will help illustrate the collected data while in the field.
- It is also helpful when using more advanced Cogo Functions.

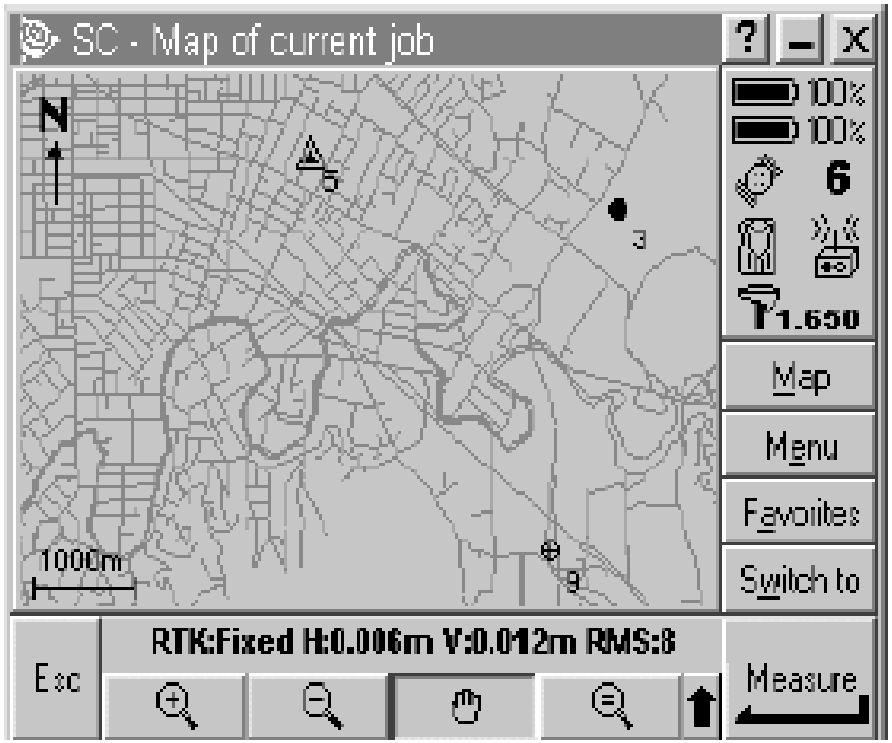
Map Function (Cont.)

- The picture shows what the map looks like with only recorded or keyed in data.
- Points are assigned different symbols.
- Using a Pcode file that has been linked to your job will draw linework on the map.



Background Maps

- A background map can be assigned under file properties
- Useful because it can help illustrate project status in the field
- Base maps are not DTM’s, and are only to be used as a graphics tool.



Edit Keyed Data

- Surveyors can edit data under the file icon with the review current job command.
- Any data that is keyed in can be edited.
- Shot may also be deleted, however the information remains in the file but is not used in the DTM.

Survey Controller Review

- Ranger Icons.
- Station establishment.
- Initialize data collection
- Autolock
- Lines and blocks for collected data
- Map functions
- Edit keyed data

Trimble S6
Robotic Total Station

Trimble S6 Robotic Total Station

- The S6 Robotic Total Station has many functions and features. To better understand the features and capability of the S6 Robotic Total Station, we will take you through the many items that make up the S6.

The Trigger Key

- When there is no Control Unit attached to the instrument, the trigger key functions as an On/Off key. An LED in the trigger key indicates if the instrument is turned on. A solid light indicates on and a flashing light indicates suspended mode.

Battery Life

- One internal battery will provide up to 6 hours of robotic operation depending on conditions.
- Three batteries in a cradle will provide up to 18 hours of use depending on conditions.
- It takes approximately 3 hours to charge one battery, when multiple batteries are plugged into the charging station they take 3 hours

MagDrive Technology

- MagDrive servo technology provides incredibly fast and smooth performance.
- MagDrive is based on a direct drive and frictionless electromagnet motor technique that provides fast accurate measurements with advanced error compensation.

MagDrive Working Modes

- MagDrive Servo’s have three working modes:
  - (a) Driving mode - movement is controlled by servo knobs or system process.
  - (b) Friction mode - motor allows the instrument to be turned manually
  - (c) Holding mode - drive works as a hard clutch to lock the instrument position and prevent small movements.

MultiTrack Targeting

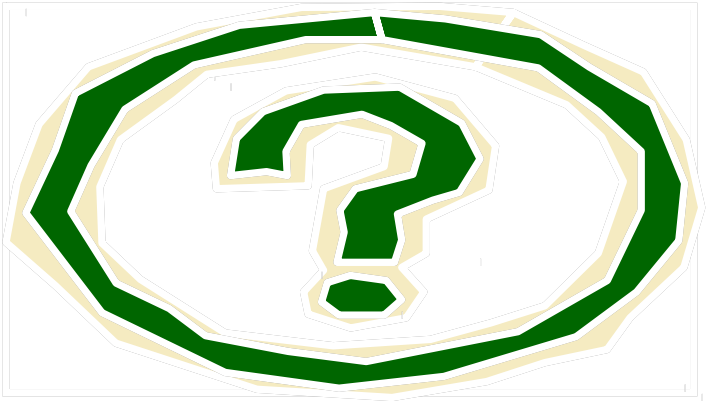
- The S6 Total Station combines passive prism tracking with active Target ID via the new Trimble MultiTrack technology. The instrument has the ability to lock and track a wide variety of targets and conventional prisms.

MultiTrack Targeting

- Target ID allows the instrument to identify a target before locking and tracking. The Target ID enables the tracker to only lock on to the Prism with the desired target ID with an infrared beam. There are 8 unique codes available meaning that there can be 8 different prisms with individual target ID’s.

MultiTrack Targeting

Why is this useful?



AutoLock

- Autolock enables the instrument to automatically lock on to a prism, and then to follow it precisely as it moves. This means that the instrument is taking care of the pointing, and that position can be continuously updated as the target moves around the jobsite.

AutoLock

- Autolock is especially useful for carrying out rapid site topo measurement and during stakeout using a conventional two person crew. It is also exceptionally useful for working in poor visibility and darkness conditions, and for automatically checking to reference targets during measurements.

SurePoint Technology

- The Trimble S6 Total Station actively corrects unwanted movements and ensures that traditional sighting errors caused by unintentional small movements of the instrument are eliminated.

Robotic Connection

- The robotic configuration allows you to detach the Trimble CU from the instrument and clip it onto a controller on the rod. This holder contains an integrated 2.4GHz radio for communication.
- You can control all the functions of the Trimble S6 from the rod as you move through the job site making measurements.

Robotic Connection

- In what cases would you use the Robotic Connection?

Collimation

- Horizontal collimation error
- Vertical collimation error
- Allows for correction of these errors to be automatically applied

Trunnion Axis Tilt

- The S6 can calculate the amount of error and then automatically apply the correction factor to all subsequent measurements

When to carry out test

- After transport
- Temperature differences greater than 10 degrees
- Accuracy requirements

Distance Measuring Technology

- Trimble S series instruments are equipped with a combined distance unit. This means that the instrument can measure to a prism or to normal surfaces (direct reflex (DR) Mode).

Distance Measuring Technology

- The instrument has a High Precision distance unit or a DR 300+ distance unit. The DR 300+ is a pulsed laser distance unit that determines distances by precisely measuring the flight time of the transmitted light pulse.

Trimble S6 Review

- Trigger key
- Battery Life
- MagDrive
- MultiTrack
- AutoLock
- SurePoint
- Robotic Connection
- Direct Reflex

Establish Project Control

Phases of Construction

- Establish Project Control
- Data Collection/ Topography
- Design/ Terramodel
- Layout/ Stakeout
- Construction
- Proofs/ As-Builts

Value of Good Project Control

- The value of good project control is that it will ensure continuity throughout all phases of construction, because it is the foundation from which all survey data will be collected.

Traverse

- A traverse is a network of points tied together by angle and distance.
- It is used as a method of control survey for a wide variety of engineering and property surveys.
- Used at the beginning of a project to ensure a higher lever of accuracy.

Locate Control Points

- Good visibility between control points
- Consider visibility during construction
- Provide redundancy in measurement
- Quality geometrics
- Optimum number of points
- Use solid ground
- Areas of Traffic

Types of Control Points

- Benchmarks
- Temporary benchmarks
- Project Control Points

Measure Rounds

- Measure Rounds is used to establish project control because it will allow the surveyor to register multiple angular measurements.
- Survey Controller will mathematically split pointing errors and provide a more accurate mean angle to the point being measured.

Measure Rounds (Cont.)

- Measure Rounds is used to make a network of points using the Least Squares Computation Method.
- The surveyor will not need to collect data in any certain order, however there is a minimum standard that must be met in order to make the network.

Measure Rounds (Cont.)

- The surveyor will need to set the instrument up on each station, **and must reference two other control points from that station.**
- This will allow Terramodel to triangulate the location of each point when the data is compiled during the downloading process.

Measure Rounds (Cont.)

- It is not necessary to zero the horizontal scale at any time during the traverse.
- All coordinates will be calculated in Terramodel from the raw data file.
- Ideally, Automated Rounds will completely eliminate instrument error and sighting errors.

Measuring Rounds of Observations

- In the next portion we show you how to measure multiple sets (rounds) of observations with a conventional instrument and the Trimble Survey Controller software. A round consists of a set of both face 1 and face 2 observations.

Measuring Rounds of Observations

- With rounds, you measure the first face observations. The Trimble Survey Controller software builds the rounds list then guides you through a specified number of rounds of observations by:

- directing you to change face when required, or doing so automatically with servo-driven instruments.

- defaulting to the correct point details for each observed station

- displaying the results and letting you delete bad data

Building the Rounds List

- The rounds list contains the points used in the rounds observations. The Trimble Survey Controller software automatically builds this list during the first round of observations made on the first face (typically face 1). The backsight point observed during station setup is added to the list first. The last point is added when the first round of observations is completed on the first face.

Building the Rounds List

- When a point is added to the rounds list, the Trimble Survey Controller software takes note of the following details:

- point name
- feature code
- target height
- prism constant
- observation method

- The Trimble Survey Controller software uses this information as the default values for all subsequent rounds observations.

Building the Rounds List

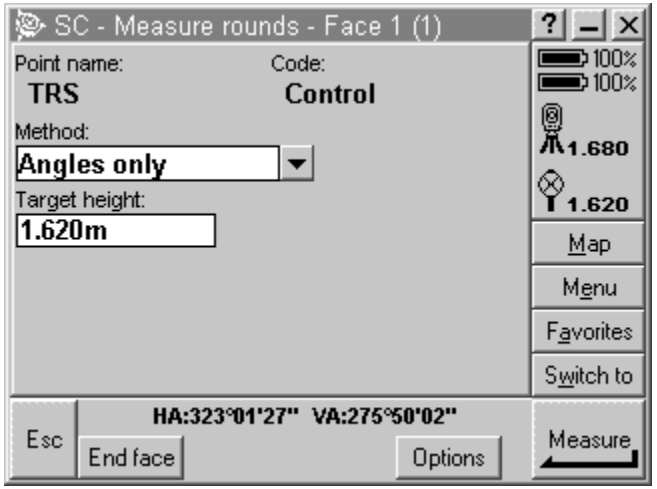
- The rounds list cannot be edited, so observe all points that are to be included in the rounds observations during the first round on the first face.

Adding Points

- To add a point to the rounds list:
- 1. Complete a station setup.
- The backsight point will be added to the rounds list first.
- 2. From the *Survey menu, select Measure rounds.*

Adding Points

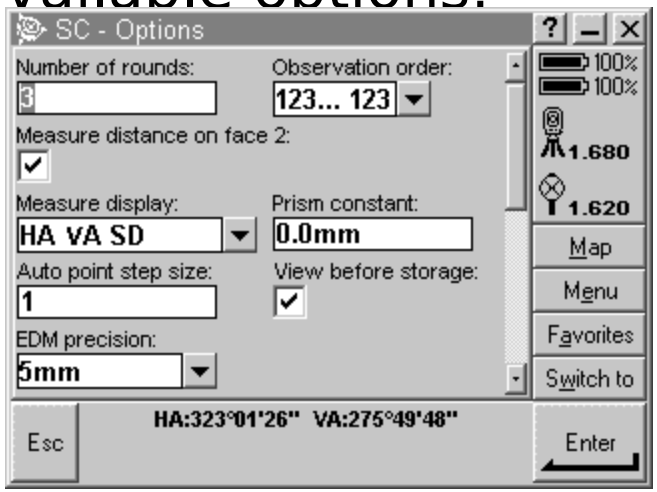
- The following screen appears:

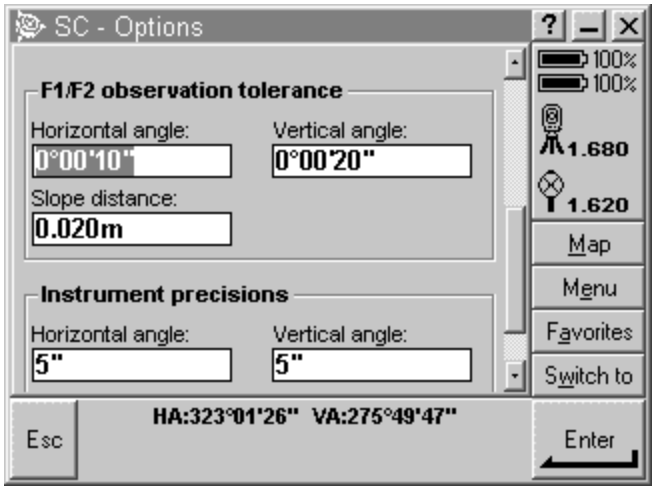


- The top of the *Measure rounds screen shows which face the* instrument is on, and the number of the current round (shown in brackets). For example, this screen shows that the instrument is on face 1 of the first round

Add Points

- 3. To change the settings for the current survey, tap options. The following screens show two of the available options:

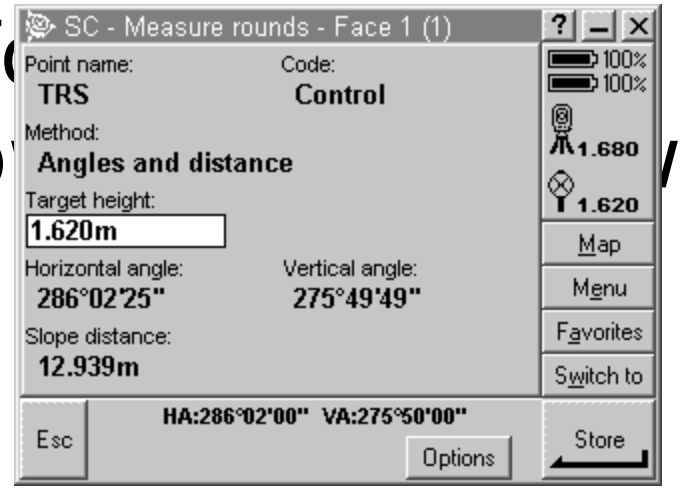




- Use the *Options screen to specify the prism constant of the* target for each observation in the rounds list. Enter a negative value if the prism constant is to be subtracted from measured distances.

Add Points

- 4. To add a point to the rounds list, follow the same procedure for measuring a topo point. If you selected the *View before storage check box in the survey* style, the measurement inf displayed, as sho ving screen:



Add Points

- 5. When the rounds list is complete, tap END FACE. The Trimble Survey Controller software prompts you for the next point to be measured in the rounds of observations.

- ***Note – If you tap ESC in the Measure rounds screen, the current rounds list is lost. A new station setup is required to start another round.***

Measuring a Point in a Round of Observations

- When the rounds list has been built, the *Measure rounds screen* displays the default target details for the next point to be observed.
- If the TSCe data collector is connected to a servo or robotic instrument, and you selected the *Stakeout auto turn check box in the* survey style, the Trimble Survey Controller software automatically turns the instrument to the calculated horizontal and vertical angle.

Making a measurement

- Once the rounds list has been built, the Trimble Survey Controller software automatically displays the last used target information for the next point to be measured. To measure a point, tap MEASURE. When the observation is stored, the Trimble Survey Controller software enters the point name and the target information as default values for the next point in the rounds.
- Repeat this procedure until all observations are completed on the face.

Skipping Observations

- During rounds observations, if the current point cannot be measured, tap SKIP to skip an observation. The Trimble Survey Controller software will then default to the next point in the rounds list.
- You cannot skip observations:
  - when building the rounds list
  - if the observations are made to the first Point (backsight) in the rounds list

Accuracy

- Accuracy is defined as the relationship between the value of measurement and the true value of the dimension being measured; the higher the accuracy the lower the error.
- Error is defined as the difference between the true value and the measured value.

Accuracy vs. Precision

- Precision is directly related to the instrument whereas Accuracy is related to the surveyor.
- Errors can be minimized by the use of skilled techniques and appropriately precise equipment.

Two Types of Errors

- Systematic Error: An error for which the magnitude and algebraic sign can be determined. Because the error can be measured it can be mathematically corrected.
- Random Error: Introduced into each measurement by the surveyor. Can be minimized by use of skilled techniques and vigilance of the individual.

Minimizing Error

- Systematic Errors can be nearly eliminated by the Survey Controller by performing the following:
  - The dual axis collimation test
  - Engaging the Dual Axis Compensator
  - Entering Temp and Barometric Pressure
  - Measuring angles in Forward and Reverse positions

Minimizing Error

- Random Error can be minimized by the following:
  - Properly measuring station and target height
  - Ensuring that the instrument is perfectly leveled and over the point
  - Use quality geometrics and design the traverse to provide redundant measurements

Adjust Field Data

- Data can be adjusted under the Raw Data Editor in Terramodel. Nearly all information that is keyed in by the surveyor can be edited for mistakes.
- **Since it is impossible to determine any angular corrections, surveys that fail tolerances will need to be surveyed again**.

Adjust Field Data (Cont.)

- Starting coordinates can be entered in under the Raw Data Editor. They can also be changed or aligned to fit a specific bearing.

Establish Project Control Review

- Value of Good Project Control.
- Locate Control Points.
- Measure Rounds.
- Minimizing Error.
- Adjust Field Data in TerraModel.

Trimble R8 (5800) Characteristics

Trimble R8 (5800) Characteristics

- The Trimble® 5800 GPS receiver is designed for GPS surveying applications. The 5800 receiver incorporates a GPS antenna, receiver, internal radio, and battery in a rugged light-weight unit that is ideally suited as an all-on-the-pole RTK rover..

Trimble R8 (5800) Characteristics

- Three LEDs allow you to monitor the satellite tracking, radio reception, data logging status, and power. Bluetooth® wireless technology provides cable free communications between receiver and controller. The 5800 receiver provides 24 total channels of L1/L2 satellite tracking, and supports logging of raw GPS observables to the handheld controller for post-processed applications.

Button Functions

- The only button on the 5800 receiver is for power. Use this button to switch the receiver on or off.

LED Behavior

- The three LEDs on the front panel of the receiver indicate various operating conditions. Generally, a lit or slowly flashing LED indicates normal operation, a LED that is flashing quickly indicates a condition that may require attention, and an unlit LED indicates that no operation is occurring.

Logging Internally

- The 5800 receiver logs GPS data internally on 2 Mb of internal memory. You can then use the Trimble Data Transfer utility to transfer logged data files to the office computer. **The transferred files are in Trimble DAT (.dat) format.**

Logging 5800 GPS Operation

- To begin internal logging, you must use a Trimble controller, or the GPS Configuration utility. The 5800 receiver does not have an internal clock, so you cannot conduct timed sessions without a Rover connected to it.

Logging to a Trimble Controller

- When the 5800 receiver is connected to a Trimble controller, you can log GPS data from the receiver to the controller. When you use a Trimble controller, you do not use the receiver's controls. Instead, you use the controller functions to set logging options, specify filenames, and control when logging occurs.

Logging to a Trimble Controller

- Data is stored in job files, which can be transferred to your office computer using Trimble's Data Transfer utility or ActiveSync.

Resetting to Defaults

- To reset the 5800 receiver to its factory default settings, hold down for at least 15 seconds.
- Do this when the receiver becomes unresponsive or locks up.

Setup Guidelines

- Environmental
  - Although the 5800 receiver has a waterproof housing, reasonable care should be taken to protect the unit. Avoid exposure to extreme environmental conditions, including:
    - Water
    - Heat greater than 65 °C (149 °F)
    - Cold less than –40 °C (–40 °F)
    - Corrosive fluids and gases

Setup Guidelines

- Electrical Interference
  - Avoid the following sources of electrical and magnetic noise:
    - Gasoline engines (spark plugs)
    - Televisions and computer monitors
    - Alternators and generators
    - Electric motors
    - Equipment with DC-to-AC converters

Setup Guidelines

- High Power Signals:
  - High power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits.
  - This does not harm the instrument, but it can prevent the receiver electronics from functioning correctly.

Trimble R8 Review

- Button Functions
- LED Behavior
- Logging Internally
- GPS Operation
- Resetting Defaults
- Set-Up

Questions?

Site Calibration

Manual Site Calibration

- Key in, transfer, or use a conventional instrument to measure the coordinates
- Check or set the calibration tolerences
- Measure the points using GPS
- Select the pairs of points to be used for calibration
- Perform the calibration
- Apply the calibration

Key in Grid Coordinates

- Select Key in / Points
- Check that coordinate fields are Northing, Easting, and Elevation if not set view setting to grid
- Enter a name
- Enter features
- Key in the known grid coordinates
- Select the Control point check box
- Repeat for each grid coordinate

Transferring Grid Coordinates

- Transfer coordinates using TBC, Data Transfer, or ASCII transfer
- Make sure that these coordinates are
  - 1) Transferred as grid coordinates (N,E,E) not as WGS-84 (L,L,H)
  - 2) Control class points

Using GPS to Measure Calibration Points

- TSC automatically matches the grid points to WGS-84 values and calculates, stores and applies the calibration

Measuring a Calibration Point

- 1. Choose Survey
- 2. Select RTK survey style
- 3. Select Measure Points and change type to Calibration Point
- 4. Access the Grid point name field and press 1. Highlight the point to be measured and press E.

Measuring a Calibration Point

- 5. Enter values for the code and antenna height fields
- 6. When the antenna is centered and vetical over the point tap M or E.
- 7. When the s soft key appears inspect the precisions. If they are satisfactory tap s
- 8. The calculations are then done automatically and the please wait storing point message appears

Measuring a Calibration Point

- 9. Enter the next calibration point name and press f
  - The graphical display screen appears with the azimuth and distance to the next point walk to the point until the arrow disappears and the point appears.
- 10. Repeat steps 4 through 9 until all points are measured

Selecting point pairs and performing the calibration

- 1. Select Survey then select real-time survey style
- 2. Select Site Calibration
- 3. Tap A
- 4. Tap next to the grid point field then tap I
- 5. Highlight the GPS point field and enter the name
- 6. In the Use field select whether to use vertical, horizontal or both

Selecting point pairs and performing the calibration

- 7. Tap C
- 8. Press W to see the shifts
- 9. To add more points tap to return to the calibration screen
- 10. Repeat steps 3 through 9 until all point are added
- 11. Do one of the following
  - If residuals are acceptable press @
  - If residuals are not acceptable recalculate

Checking the Residuals

- Residuals only appear if tolerances are exceeded
- If the residuals are excessive consider removing the point with the most extreme residuals then
  - If four or more points remain recalibrate using remaining points
  - If fewer than 4 points remain measure the point again and recalibrate

Checking the Residuals

- You may have to remove and measure again multiple points
- To remove a point
  - 1. Tap the point name
  - 2. Set the Use check box to OFF. Tap C
  - 3. Tap @ to accept the calibration

Recalculating a Calibration

- Recalculate a calibration if the residuals are not acceptable, or if you want to add or delete points. Recalculate using one of the following
  - Some of the points
  - Only the horizontal component of a point
  - Only the vertical component of a point

To Recalculate a Calibration

- 1. Select Survey and real time survey style
- 2. Select Site Calibration from survey menu
- 3. Do one of the following
  - Add a point
  - Change the components of a point
- 4. Press @ to apply the new calibration

Viewing a Report

- Horizontal adjustment scale factor
- Max vertical adjustment inclination
- Max horizontal and vertical residual
- A detailed report of the calibration computation appears in the default HTML viewer on your computer. It is saved in the projects reports folder

Calibration Report Includes

- Project details
- Datum transformation parameters
- Updated default projection definition
- Horizontal adjustment parameters
- Vertical adjustment parameters
- Geoid model definition
- Residual differences

Applying the Calibration

- In the GPS Site Calibration dialog click OK
- To view the coordinate system details
  - 1. Select File / Project Properties
  - 2. In the Coordinate system tab click Details
  - 3. Select the Adjustment tab to view the parameters

Site Calibration Review

- Manual Site Calibration
- Keying in Coordinates
- Transferring Grid Coordinates
- GPS to Measure Calibration Points
- Checking Residuals
- Recalculating a Calculation
- Viewing a Report
- Calibration Reports
- Applying Calibration